An Alternative Approach to Oysters:
Making Sense of Nonsensical Data

Robert W. McFarlane
McFarlane & Associates
Houston, Texas

A Presentation to the
Trinity and San Jacinto Rivers and Galveston Bay
Basin and Bay Expert Science Team
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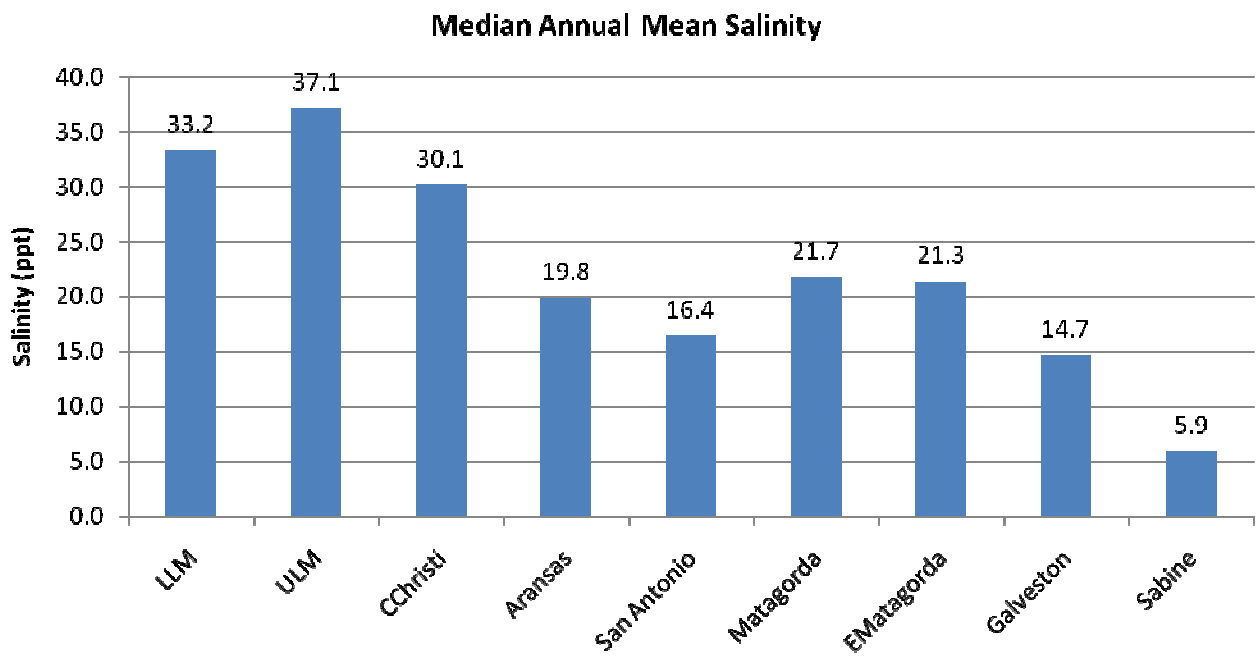
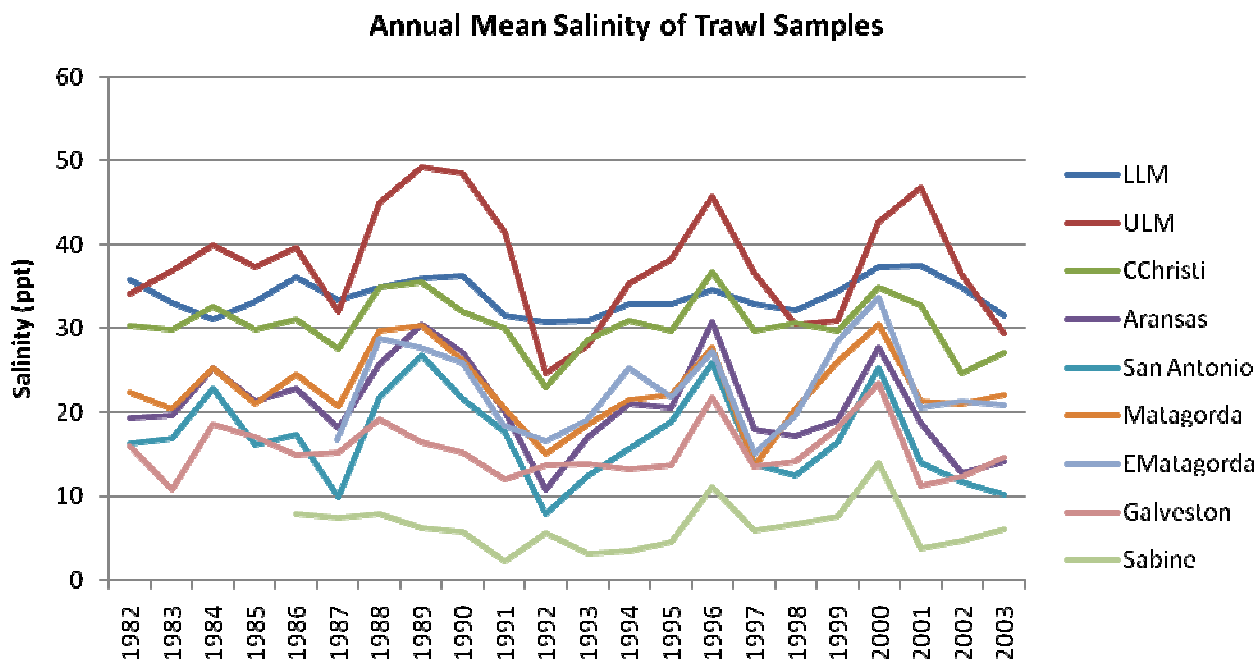
The Eastern Oyster is

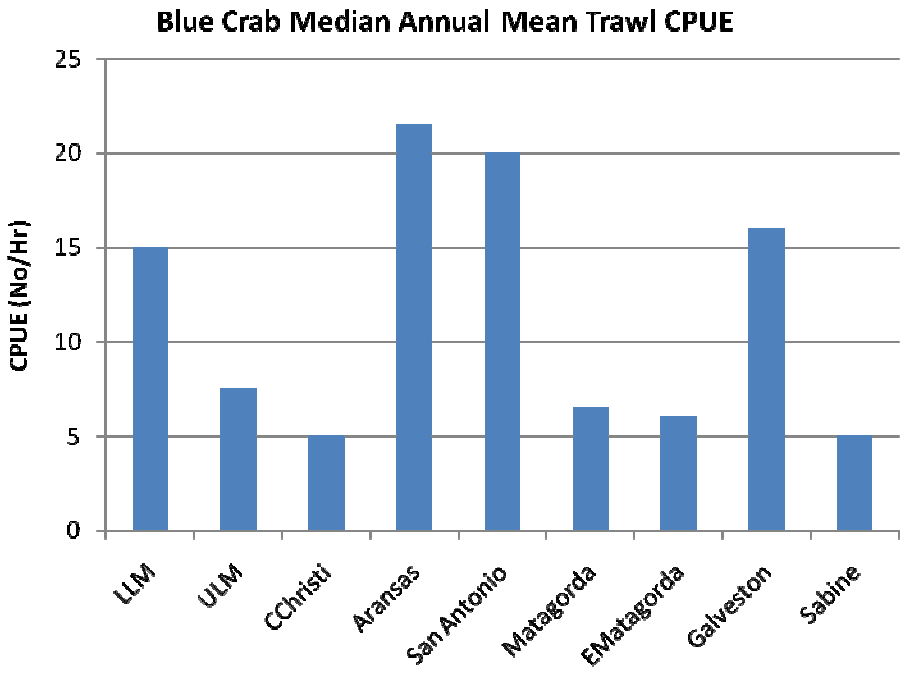
- An ECONOMICALLY IMPORTANT species
- An ecologically important KEYSTONE SPECIES that, as an ecological engineer, creates valuable OYSTER REEF HABITAT that benefits many other species
- And, possibly, an important INDICATOR SPECIES useful to identify and maintain an ecologically sound environment.

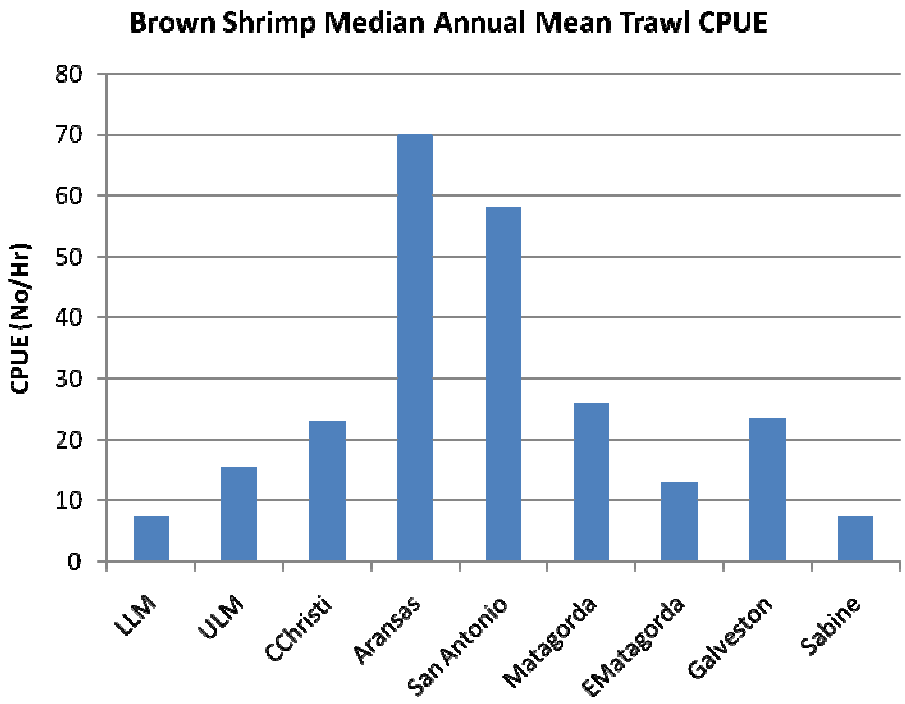
R.E. Turner (2006) compared commercial oyster harvests and river discharge for the period 1950-2003, using 3-yr running averages, for five estuaries from east Texas to west Florida

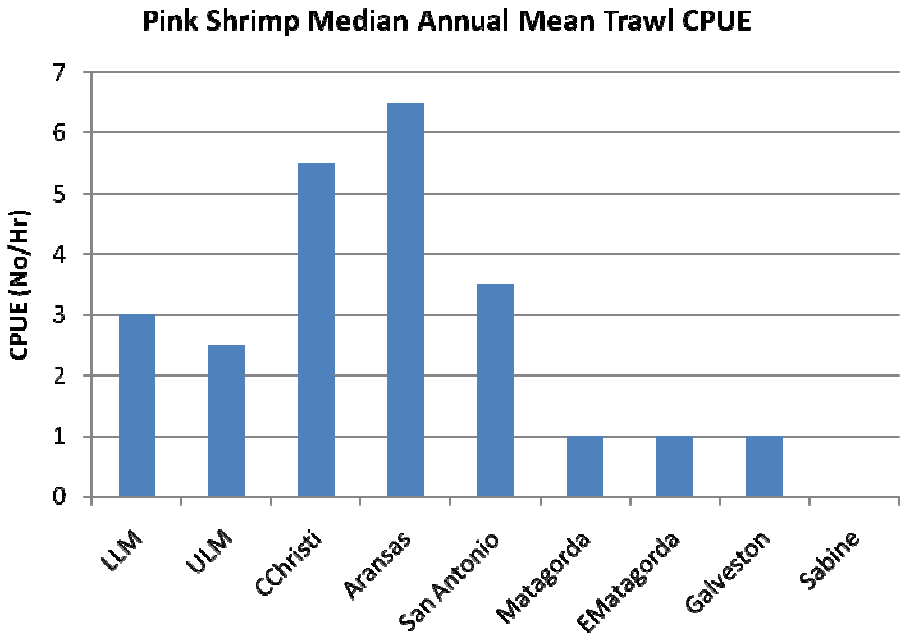
- He concluded that peaks in landings were coincident with lows in river discharge (21 of 23) and lows in landings coincided with highs in river discharge (17 of 19), and that
- Oyster landings were inversely related to freshwater inflow.

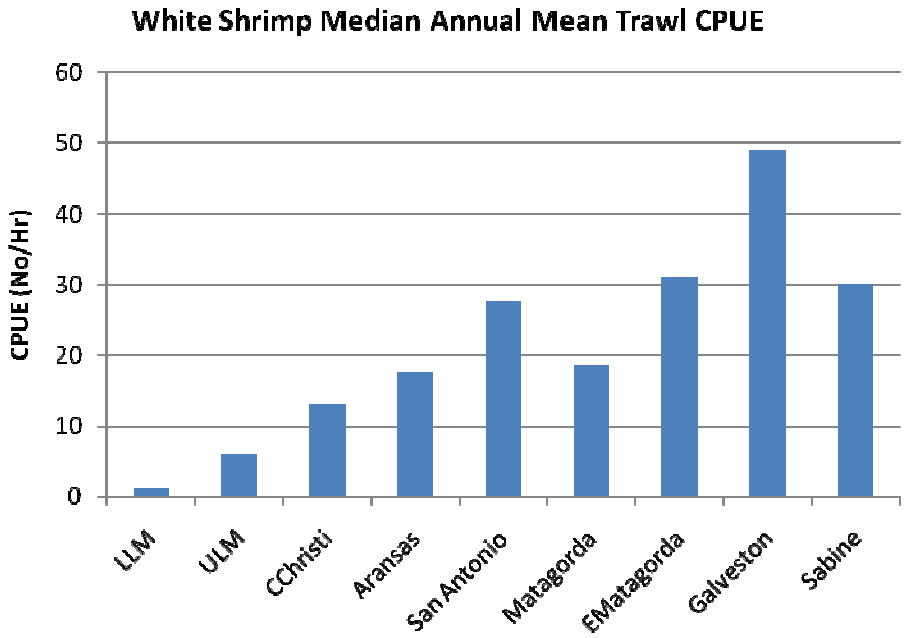

Median Annual Mean Salinity
Salinity (ppt)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
33.2
37.1
30.1
19.8
16.4
21.7
21.3
14.7
5.9
LLM
ULM
CChristi
Aransas
San Antonio
Matagorda
EMatagorda
Galveston
Sabine

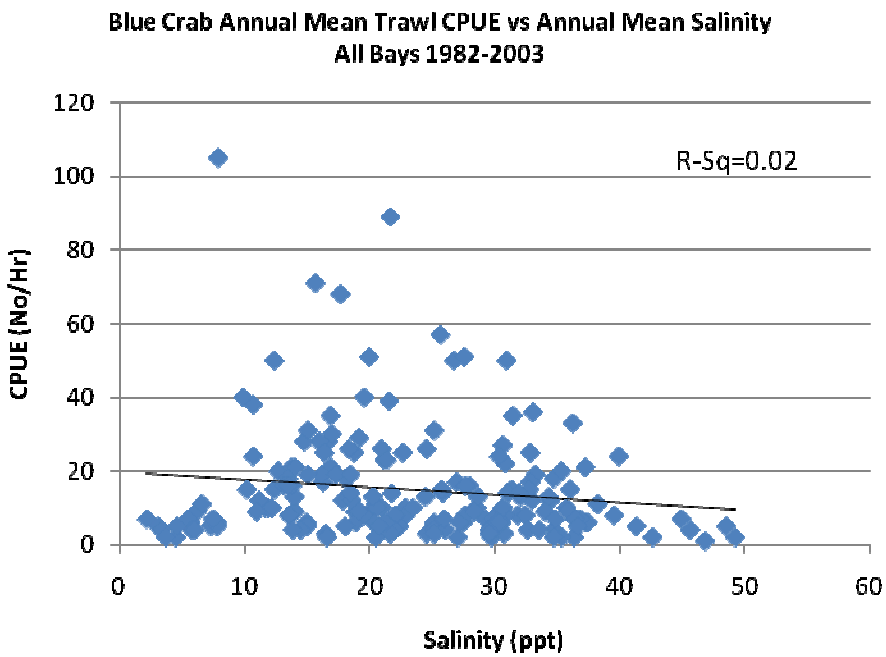

Annual Mean Salinity of Trawl Samples
Salinity (ppt)
60
50
40
30
20
10
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
LLM
ULM
CChristi
Aransas
San Antonio
Matagorda
EMatagorda
Galveston
Sabine

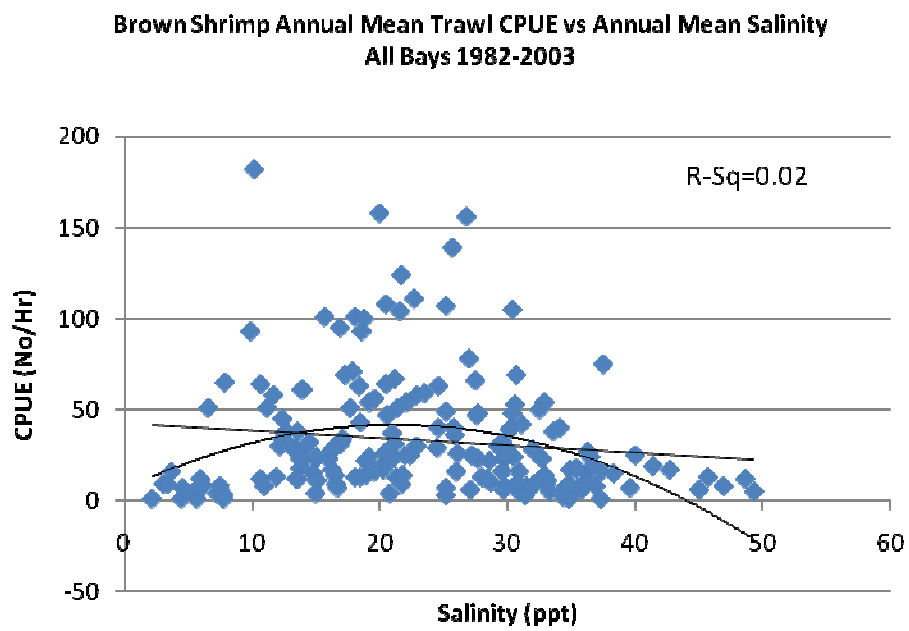

Blue Crab Median Annual Mean Trawl CPUE
CPUE (No/Hr)
0
5
10
15
20
25
LLM
ULM
CChristi
Aransas
San Antonio
Matagorda
EMatagorda
Galveston
Sabine

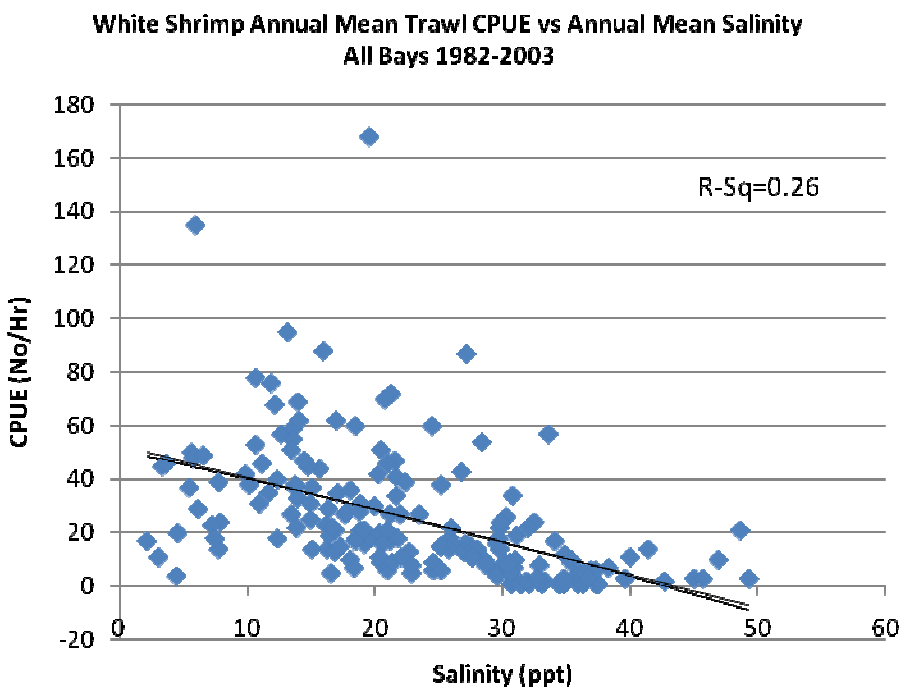

Brown Shrimp Median Annual Mean Trawl CPUE
CPUE (No/Hr)
0
10
20
30
40
50
60
70
80
LLM
ULM
CChristi
Aransas
San Antonio
Matagorda
EMatagorda
Galveston
Sabine

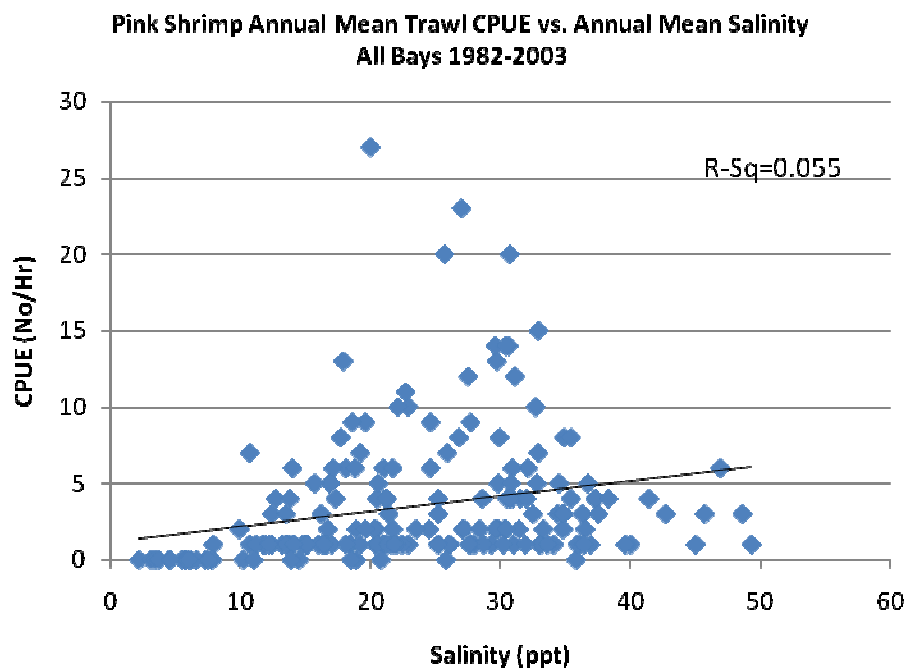

Pink Shrimp Median Annual Mean Trawl CPUE
CPUE (No/Hr)
0
1
2
3
4
5
6
7
LLM
ULM
CChristi
Aransas
San Antonio
Matagorda
EMatagorda
Galveston
Sabine

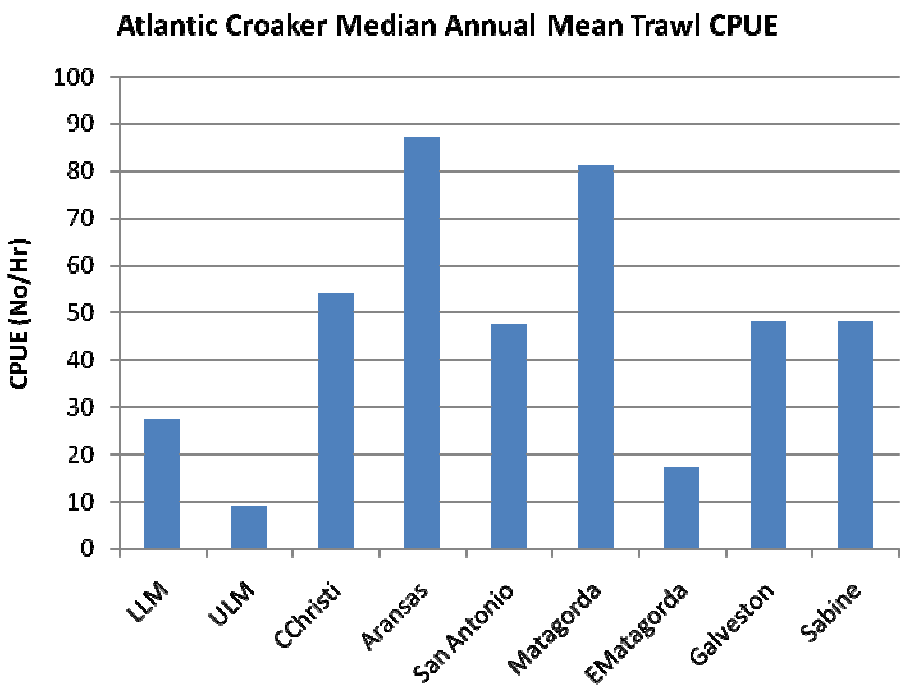

White Shrimp Median Annual Mean Trawl CPUE
CPUE (No/Hr)
0
10
20
30
40
50
60
LLM
ULM
CChristi
Aransas
San Antonio
Matagorda
EMatagorda
Galveston
Sabine

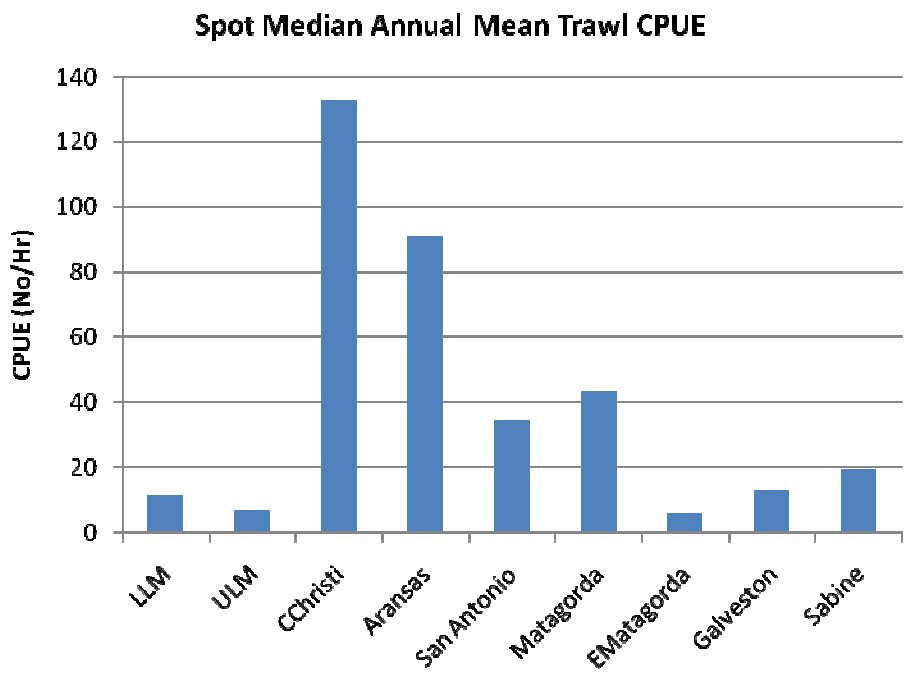

Blue Crab Annual Mean Trawl CPUE vs Annual Mean Salinity
All Bays 1982-2003
R-Sq=0.02
CPUE (No/Hr)
Salinity (ppt)
120
100
80
60
40
20
0
0
10
20
30
40
50
60

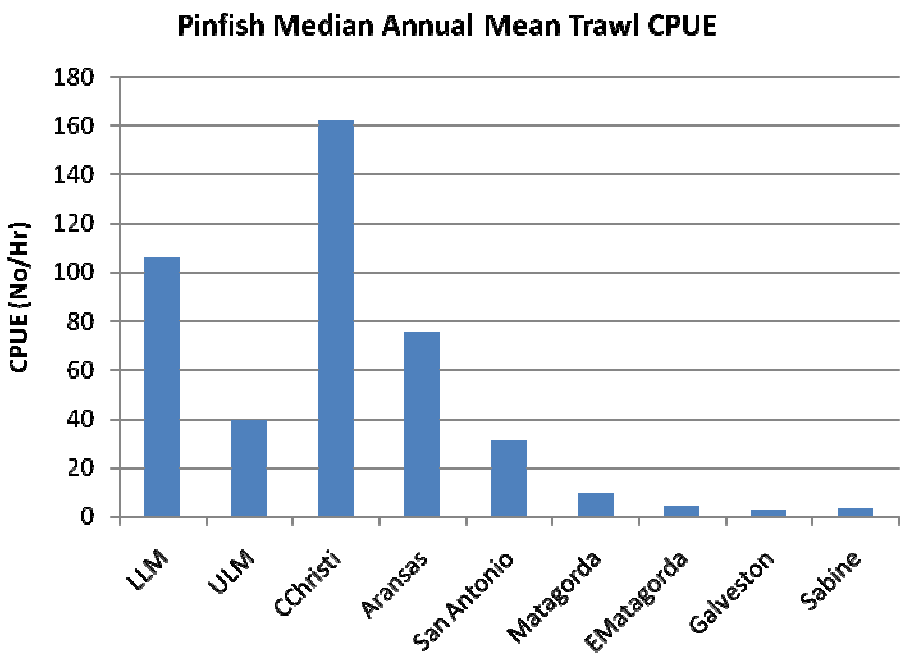

Brown Shrimp Annual Mean Trawl CPUE vs Annual Mean Salinity
All Bays 1982-2003
R-Sq=0.02
CPUE (No/Hr)
Salinity (ppt)
200
150
100
50
0
-50
0
10
20
30
40
50
60

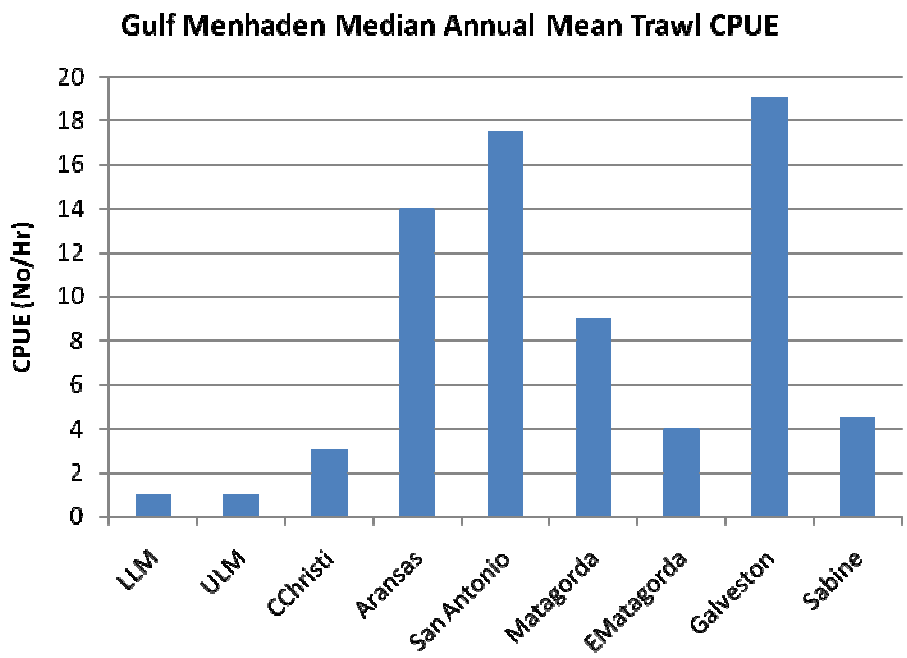

White Shrimp Annual Mean Trawl CPUE vs Annual Mean Salinity
All Bays 1982-2003
R-Sq=0.26
CPUE (No/Hr)
Salinity (ppt)
180
160
140
120
100
80
60
40
20
0
-20
0
10
20
30
40
50
60

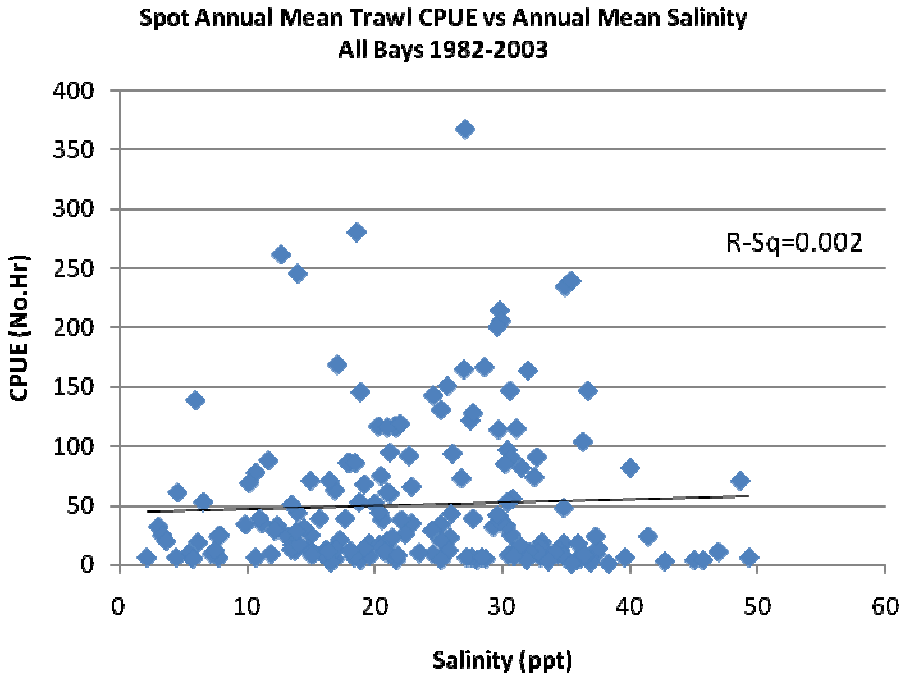

Pink Shrimp Annual Mean Trawl CPUE vs. Annual Mean Salinity
All Bays 1982-2003
R-Sq=0.055
CPUE (No/Hr)
Salinity (ppt)
30
25
20
15
10
5
0
0
10
20
30
40
50
60

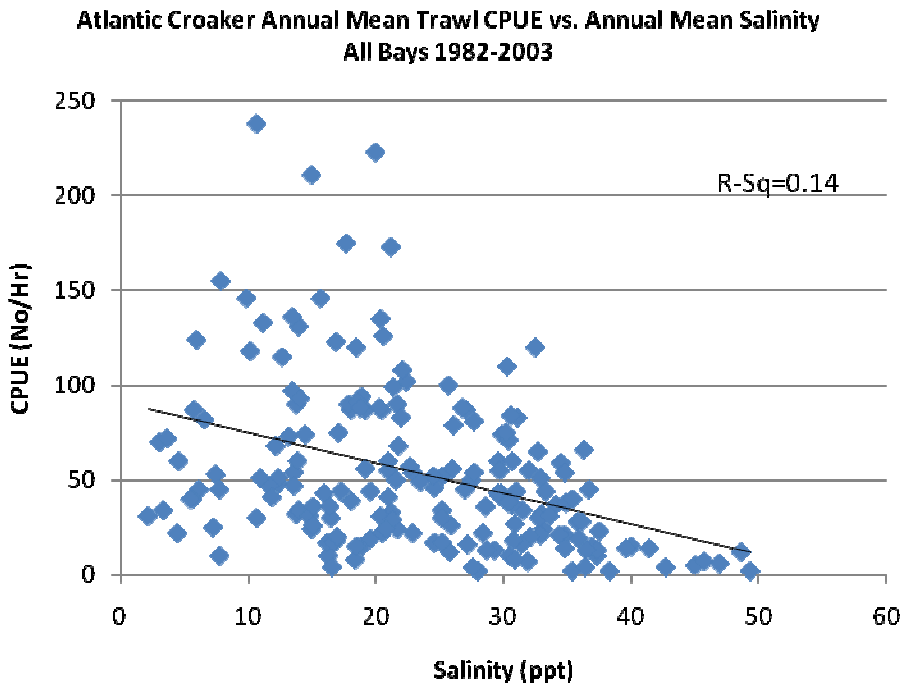

Atlantic Croaker Median Annual Mean Trawl CPUE
CPUE (No/Hr)
0
10
20
30
40
50
60
70
80
90
100
LLM
ULM
CChristi
Aransas
San Antonio
Matagorda
EMatagorda
Galveston
Sabine

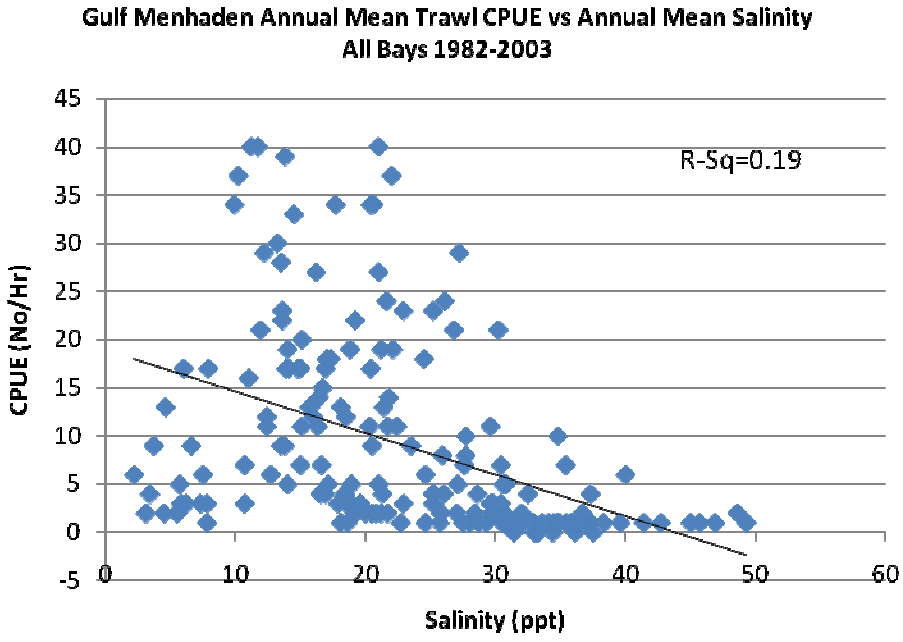

Spot Median Annual Mean Trawl CPUE
CPUE (No/Hr)
0
20
40
60
80
100
120
140
LLM
ULM
CChristi
Aransas
San Antonio
Matagorda
EMatagorda
Galveston
Sabine

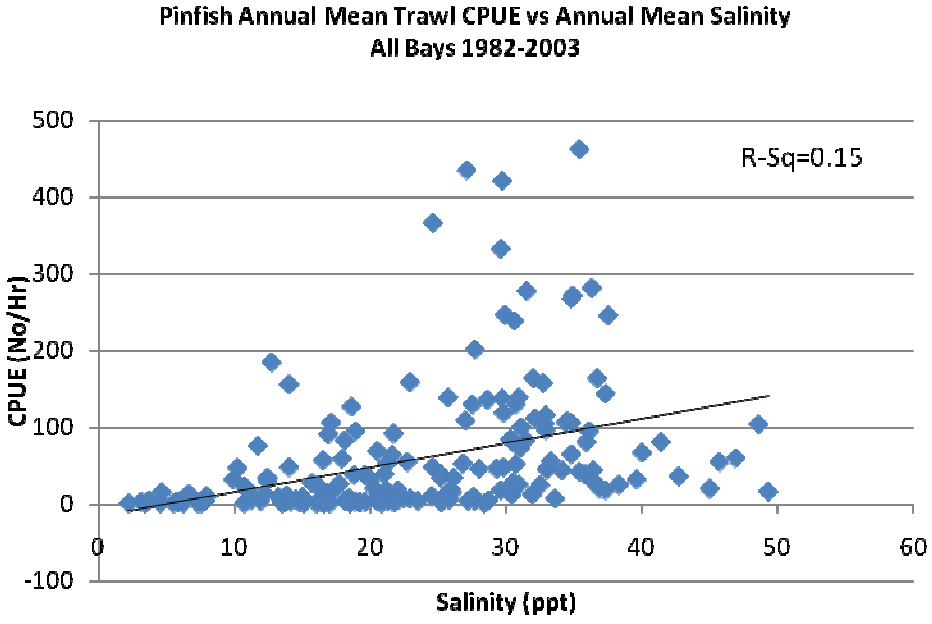

Pinfish Median Annual Mean Trawl CPUE
CPUE (No/Hr)
0
20
40
60
80
100
120
140
160
180
LLM
ULM
CChristi
Aransas
San Antonio
Matagorda
EMatagorda
Galveston
Sabine

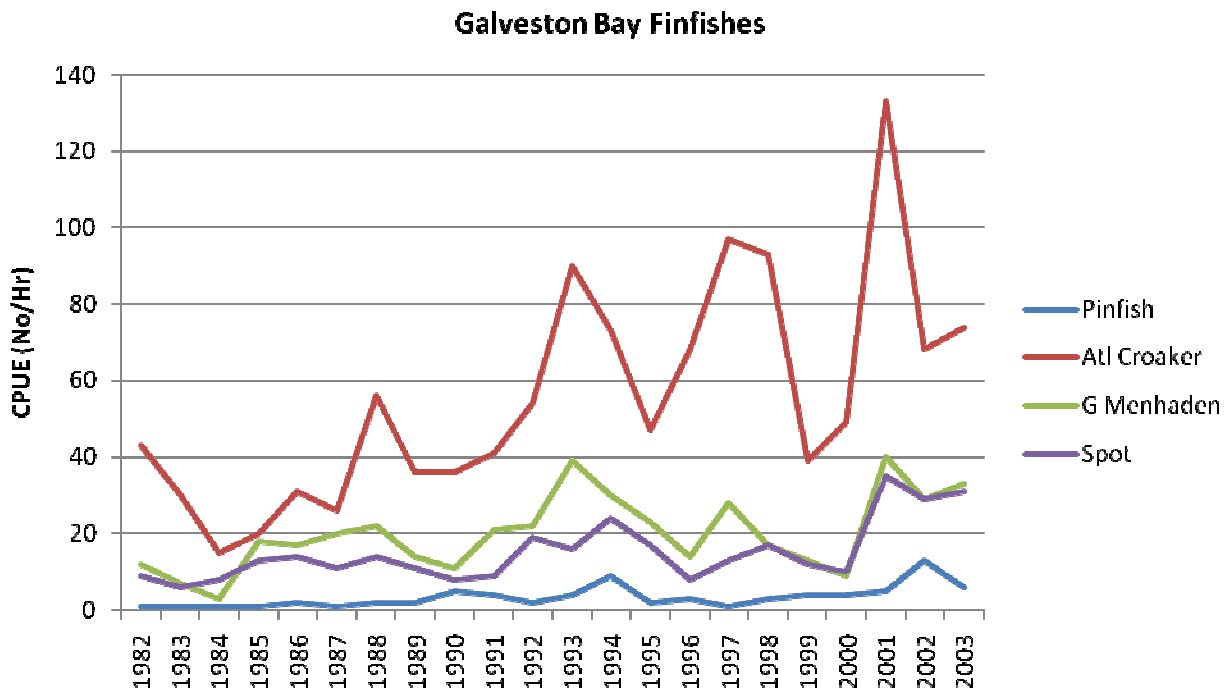

Gulf Menhaden Median Annual Mean Trawl CPUE
CPUE (No/Hr)
0
2
4
6
8
10
12
14
16
18
20
LLM
ULM
CChristi
Aransas
San Antonio
Matagorda
EMatagorda
Galveston
Sabine

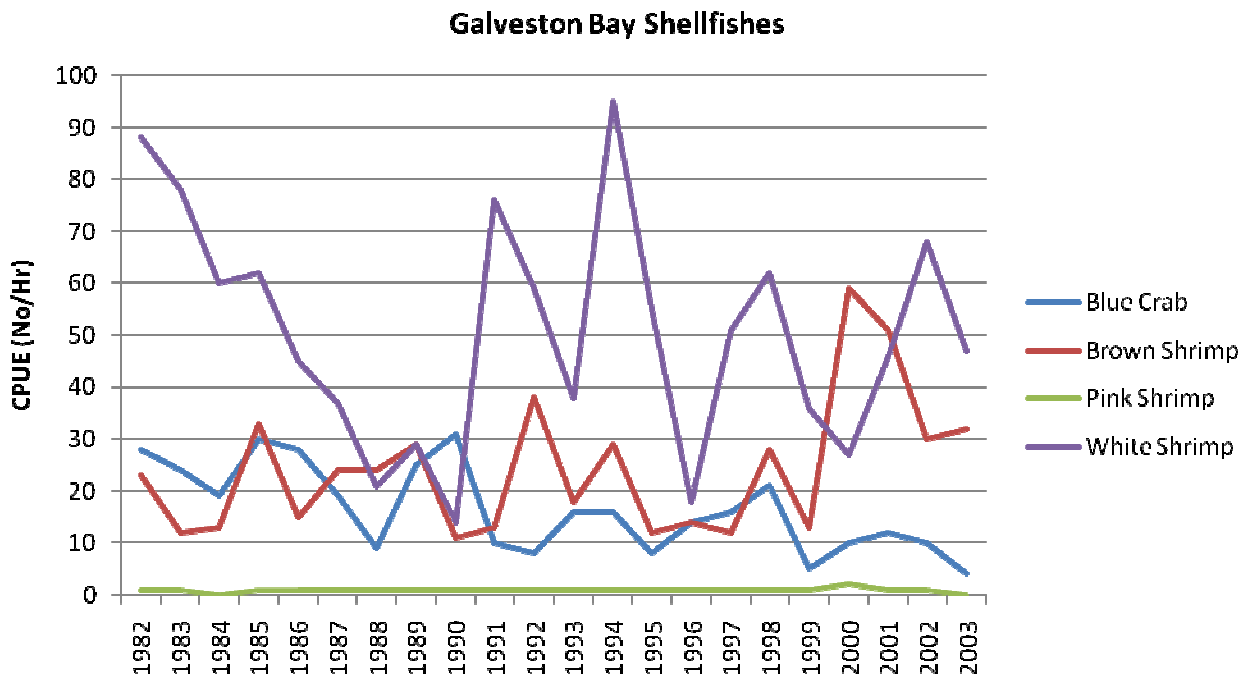

Spot Annual Mean Trawl CPUE vs Annual Mean Salinity
All Bays 1982-2003
R-Sq=0.002
CPUE (No.Hr)
Salinity (ppt)
400
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60

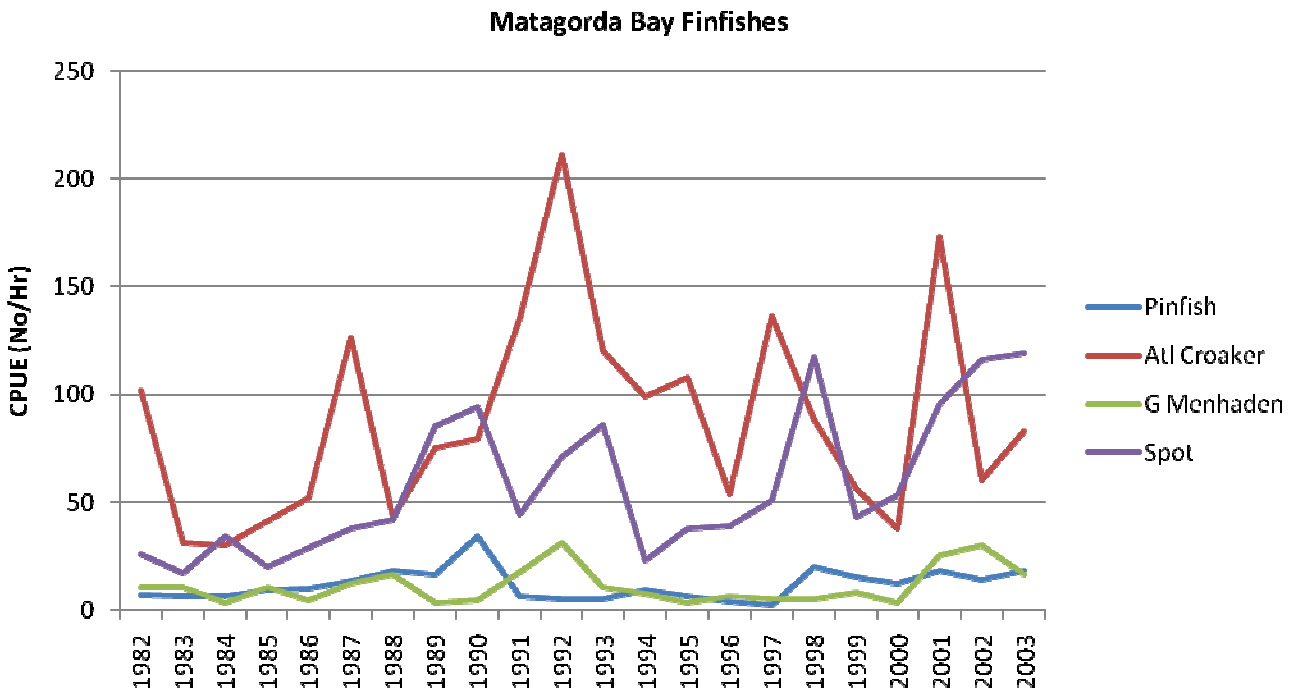

Atlantic Croaker Annual Mean Trawl CPUE vs. Annual Mean Salinity
All Bays 1982-2003
R-Sq=0.14
CPUE (No/Hr)
Salinity (ppt)
250
200
150
100
50
0
0
10
20
30
40
50
60

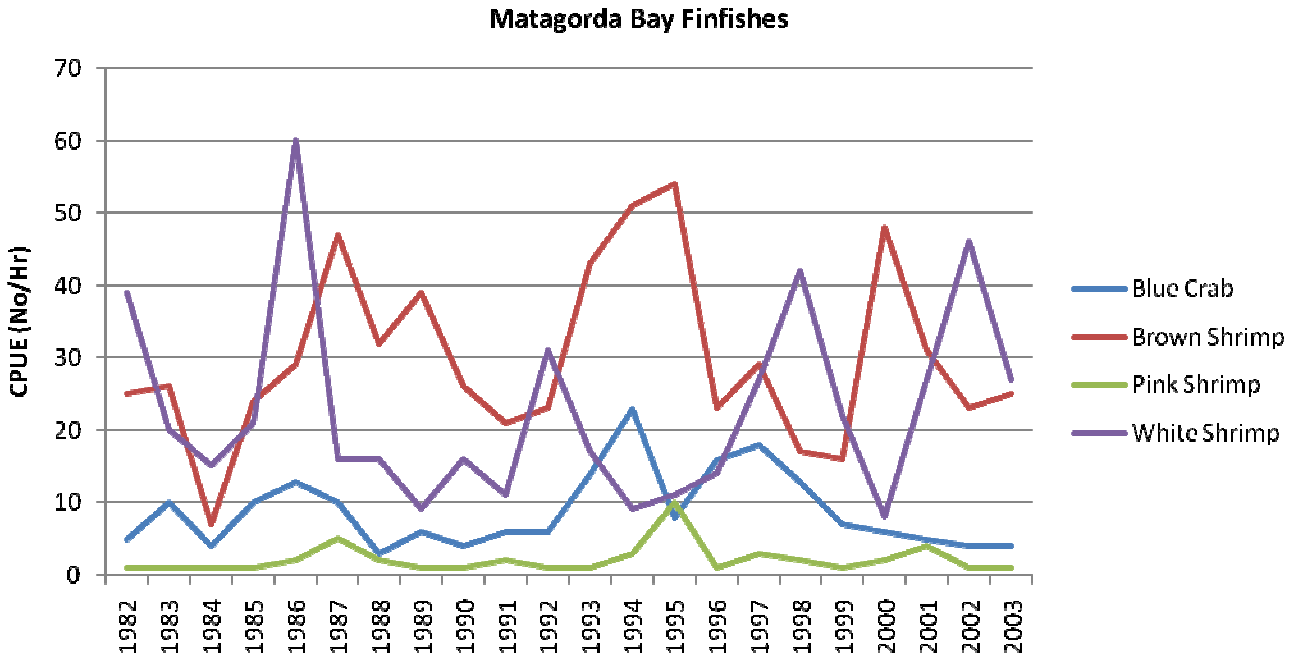

Gulf Menhaden Annual Mean Trawl CPUE vs Annual Mean Salinity
All Bays 1982-2003
R-Sq=0.19
CPUE (No/Hr)
Salinity (ppt)
45
40
35
30
25
20
15
10
5
0
-5
0
10
20
30
40
50
60

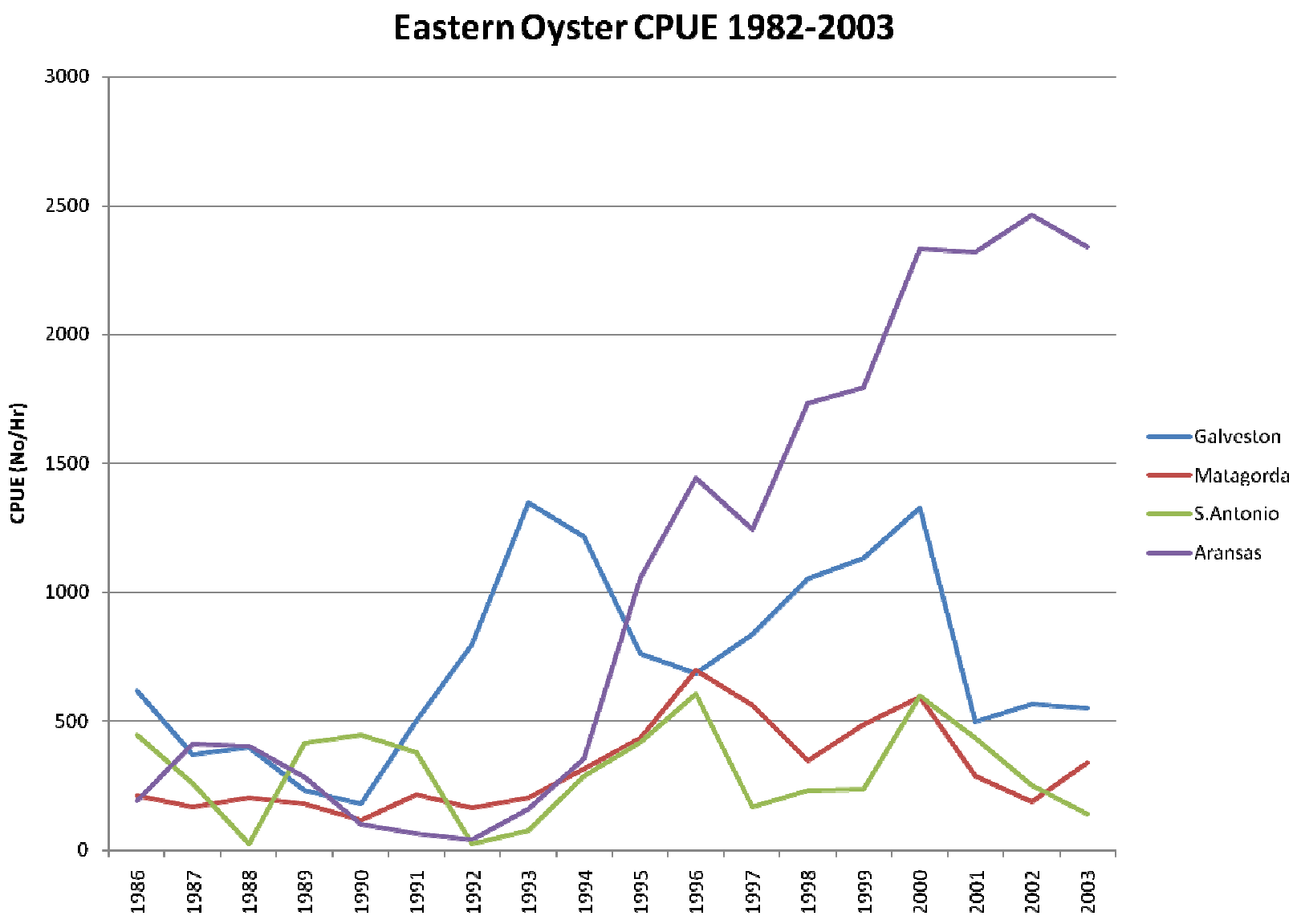

Pinfish Annual Mean Trawl CPUE vs Annual Mean Salinity
All Bays 1982-2003
R-Sq=0.15
CPUE (No/Hr)
Salinity (ppt)
500
400
300
200
100
0
-100
0
10
20
30
40
50
60


Galveston Bay Finfishes
CPUE (No/Hr)
140
120
100
80
60
40
20
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
Pinfish
Atl Croaker
G Menhaden
Spot


Galveston Bay Shellfishes
CPUE (No/Hr)
100
90
80
70
60
50
40
30
20
10
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
Blue Crab
Brown Shrimp
Pink Shrimp
White Shrimp

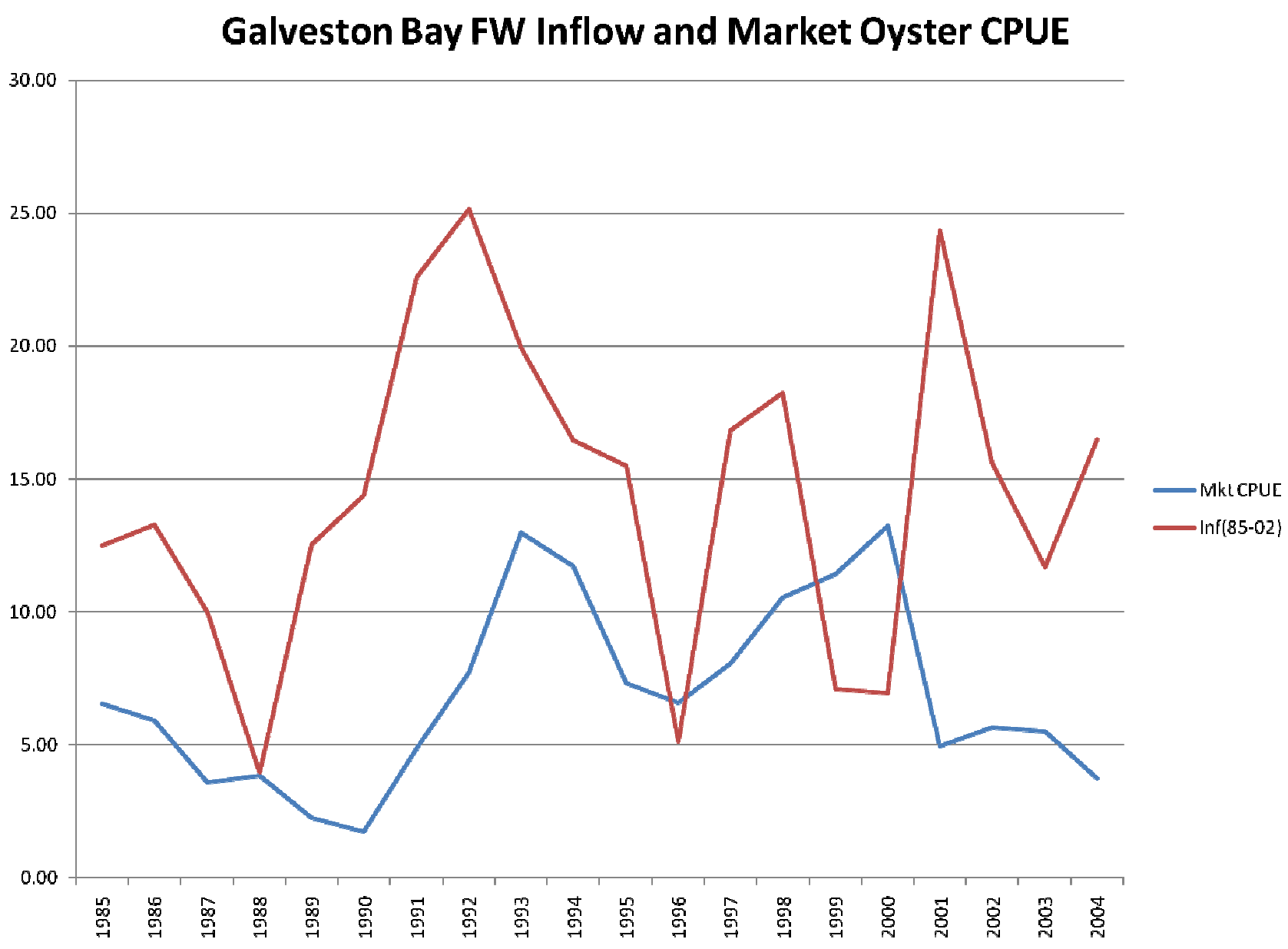

Matagorda Bay Finfishes
CPUE (No/Hr)
250
200
150
100
50
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
Pinfish
Atl Croaker
G Menhaden
Spot


Matagorda Bay Finfishes
CPUE (No/Hr)
70
60
50
40
30
20
10
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
Blue Crab
Brown Shrimp
Pink Shrimp
White Shrimp


Eastern Oyster CPUE 1982-2003
CPUE (No/Hr)
3000
2500
2000
1500
1000
500
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
Galveston
Matagorda
S.Antonio
Aransas

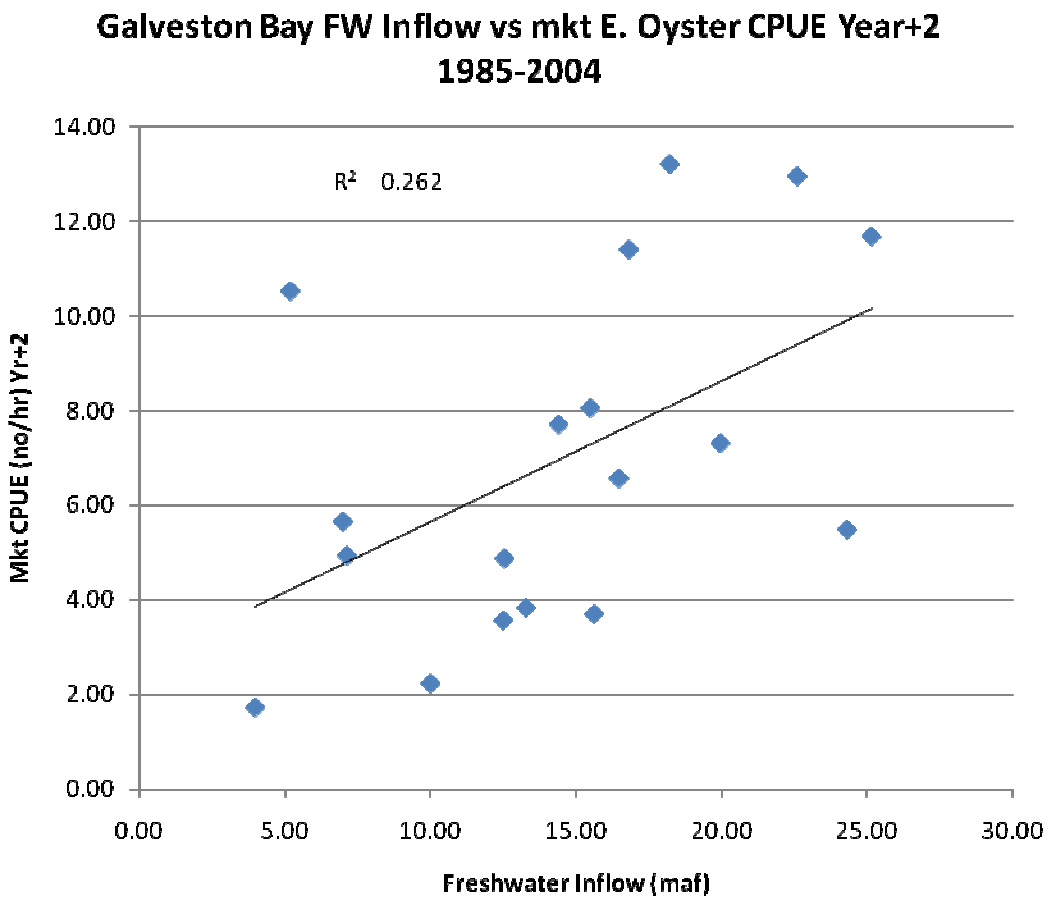
Buzan et al. (2009) examined fishery-independent oyster CPUE and concluded

- Market-sized oysters (>3 inches) demonstrate increased abundance (measured as CPUE) 1 to 2 years after years with increased freshwater inflow and decreased salinity.


Galveston Bay FW Inflow and Market Oyster CPUE
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Mkt CPUE
Inf(85-02)

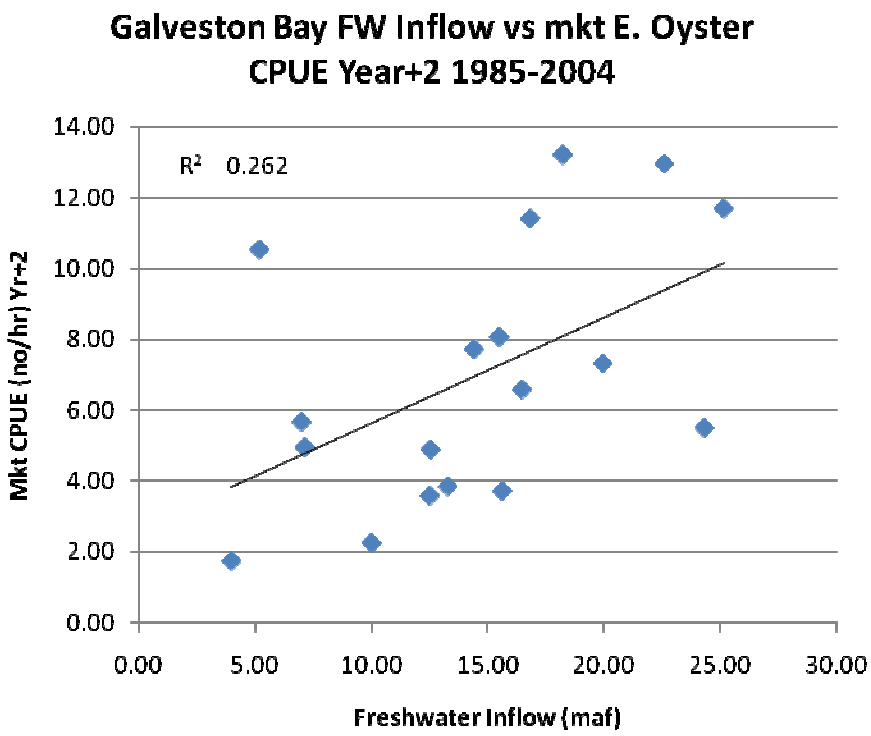
Compare Freshwater Inflow to Market Oyster CPUE

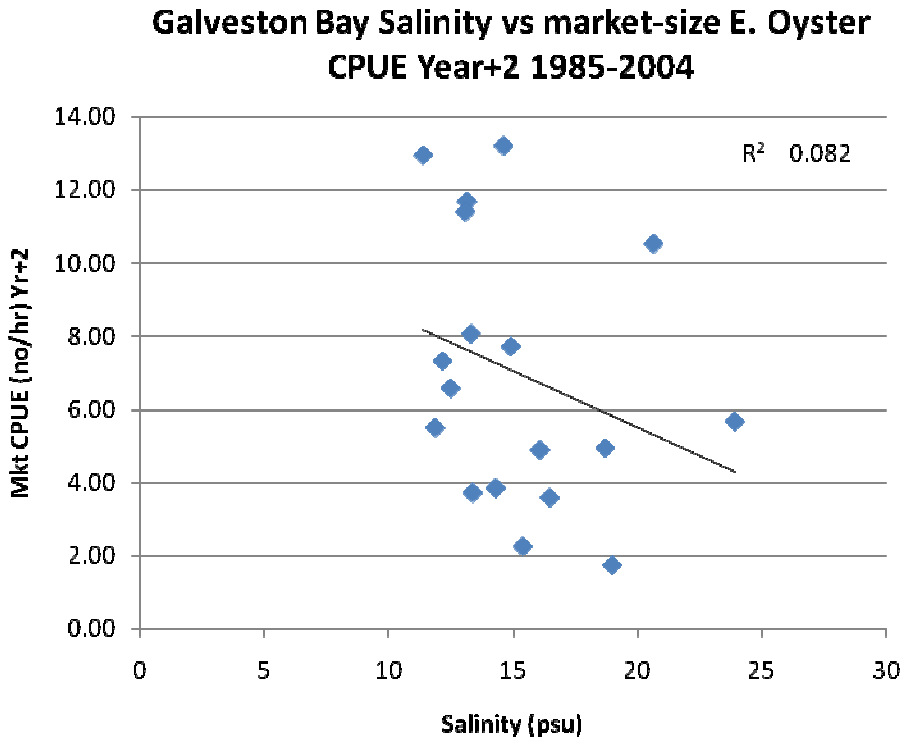
	R-Square	Probability
Same Year	0.006	0.920
Year + 1	0.16	0.094
Year + 2	**0.26**	**0.030**

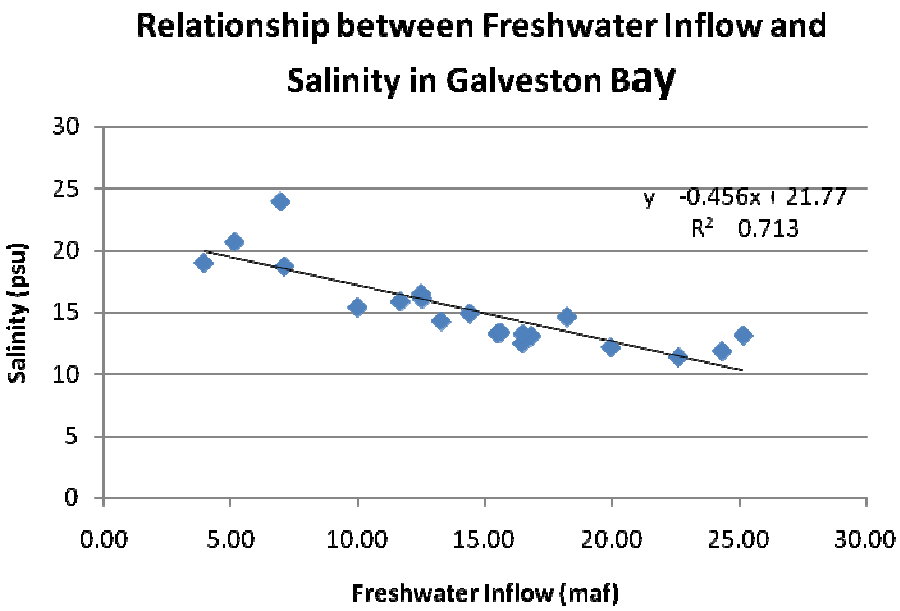


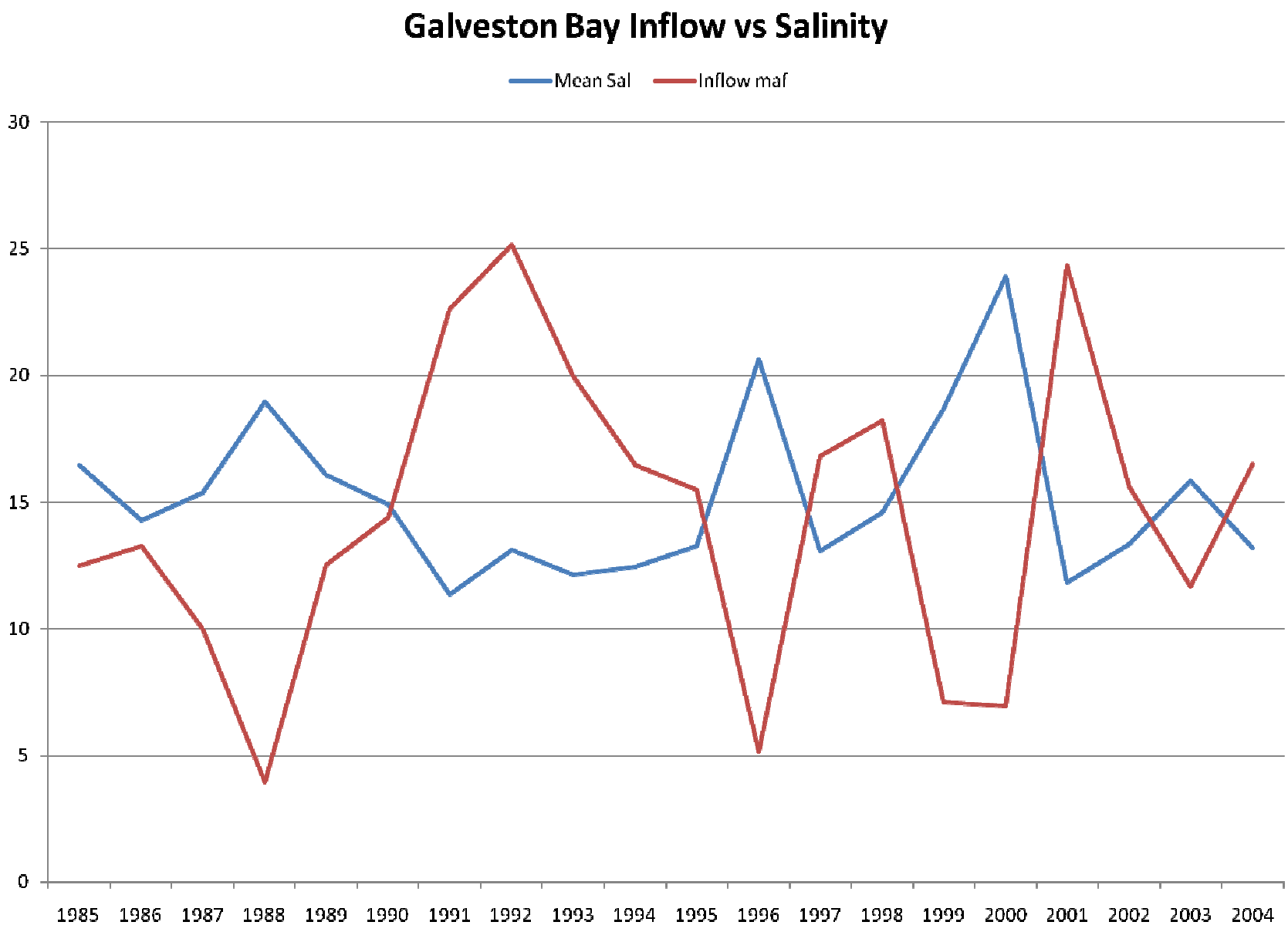
Cross-Correlations

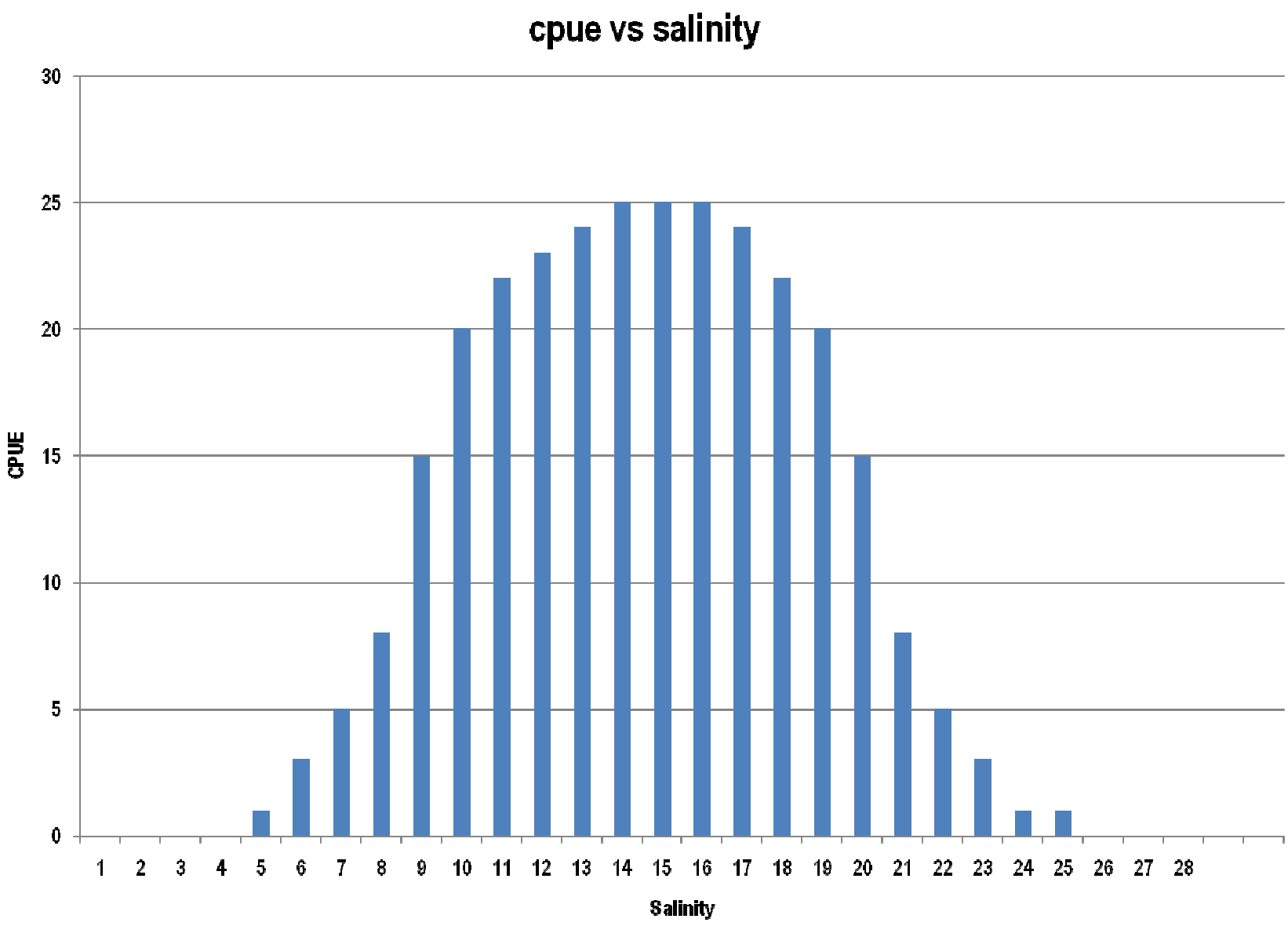
Comparison	Year	R-Square	Probability
Inflow v. CPUE	same	0.0006	0.920
	Year + 1	0.156	0.094
	Year + 2	**0.262**	**0.030**
Inflow v. Landings	same	0.019	0.560
	Year + 1	0.069	0.276
	Year + 2	0.124	0.152
Salinity v. CPUE	same	0.032	0.449
	Year + 1	0.047	0.373
	Year + 2	0.083	0.247
Salinity v. Landings	same	0.014	0.623
	Year + 1	0.041	0.409
	Year + 2	0.0004	0.940
Inflow v. Salinity	Same	**0.714**	**0.000003**
CPUE v. Landings	same	0.022	0.533

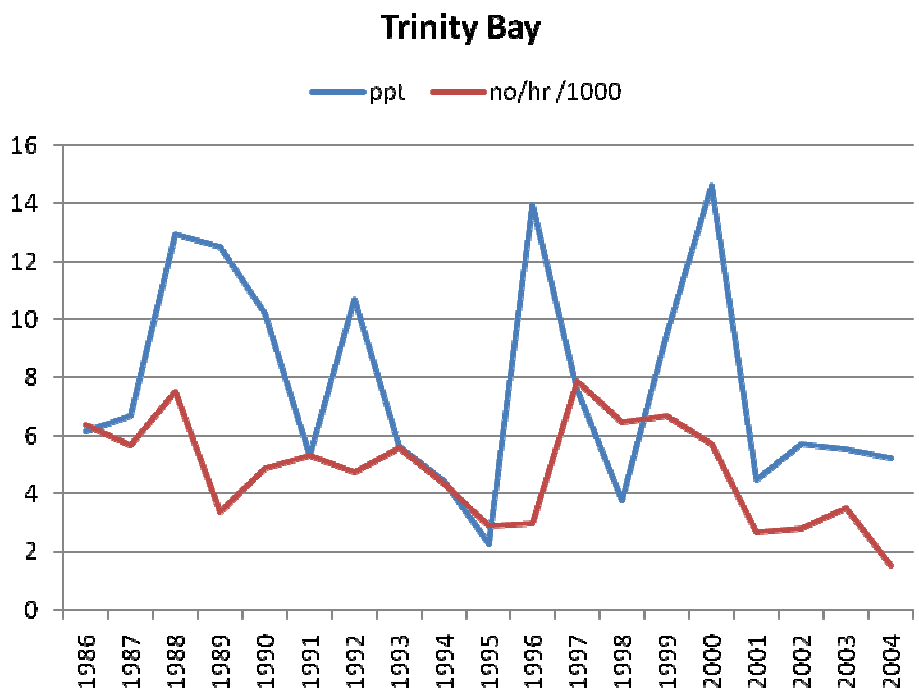

Galveston Bay FW Inflow vs mkt E. Oyster CPUE Year+2 1985-2004
R² 0.262
Mkt CPUE (no/hr) Yr+2
Freshwater Inflow (maf)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00

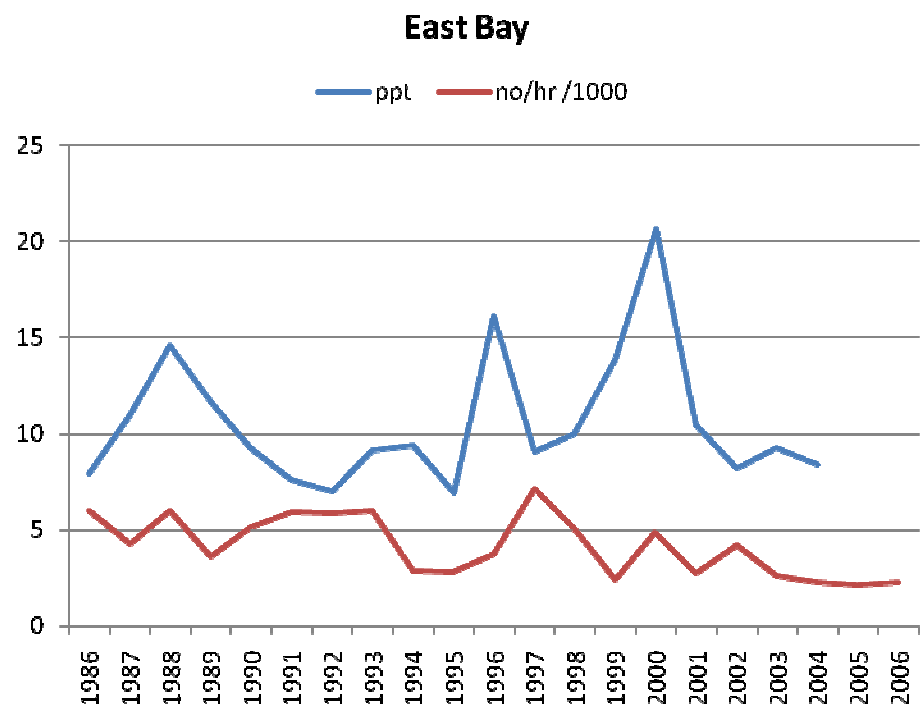

Galveston Bay Salinity vs market-size E. Oyster CPUE Year+2 1985-2004
R² 0.082
Mkt CPUE (no/hr) Yr+2
Salinity (psu)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
5
10
15
20
25
30

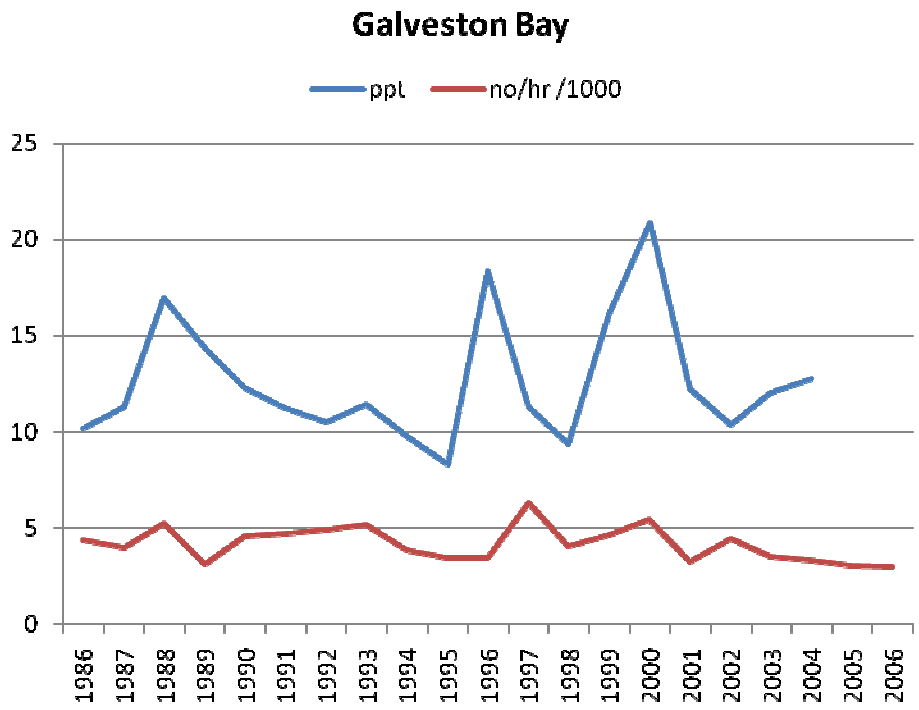

Relationship between Freshwater Inflow and Salinity in Galveston Bay
y -0.456x + 21.77
R² 0.713
Salinity (psu)
Freshwater Inflow (maf)
30
25
20
15
10
5
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00

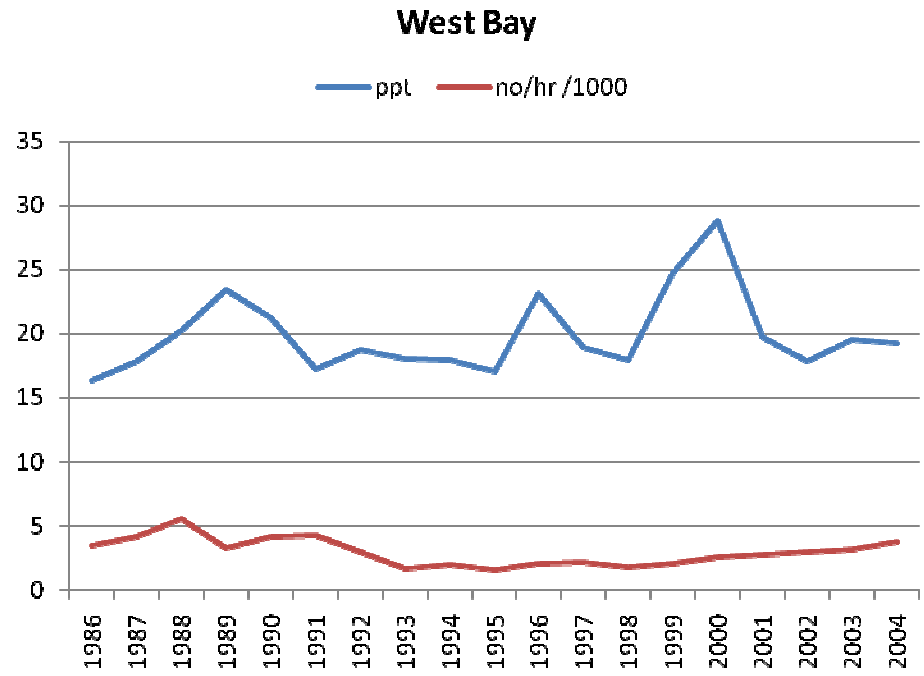

Galveston Bay Inflow vs Salinity
Mean Sal
Inflow maf
30
25
20
15
10
5
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004


cpue vs salinity
CPUE
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Salinity


Trinity Bay
ppt
no/hr /1000
16
14
12
10
8
6
4
2
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004


East Bay
ppt
no/hr /1000
25
20
15
10
5
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006

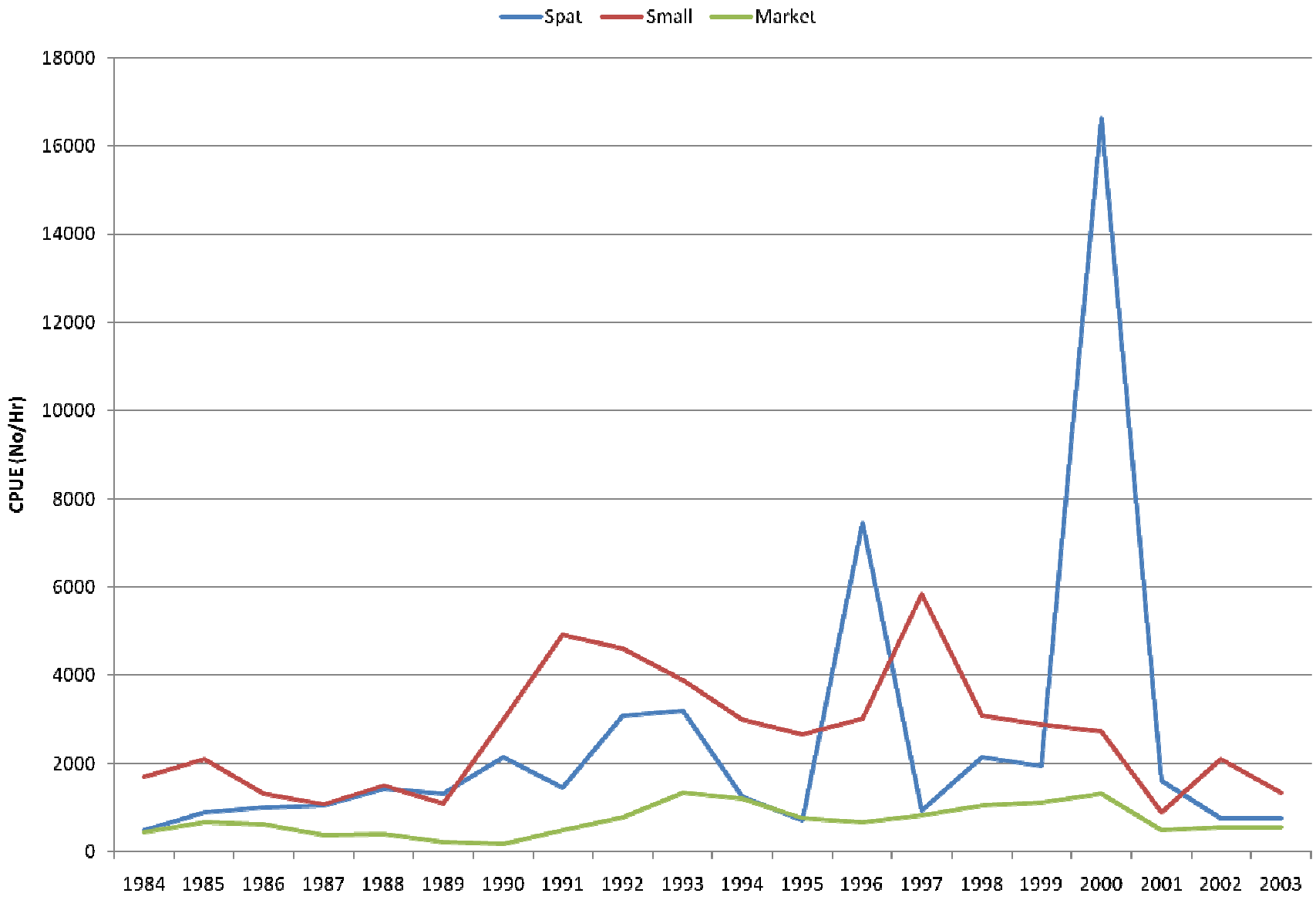

Galveston Bay
ppt
no/hr /1000
25
20
15
10
5
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006


West Bay
ppt
no/hr /1000
35
30
25
20
15
10
5
0
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004

Correlation between annual mean salinity and annual mean CPUE (no/hr)

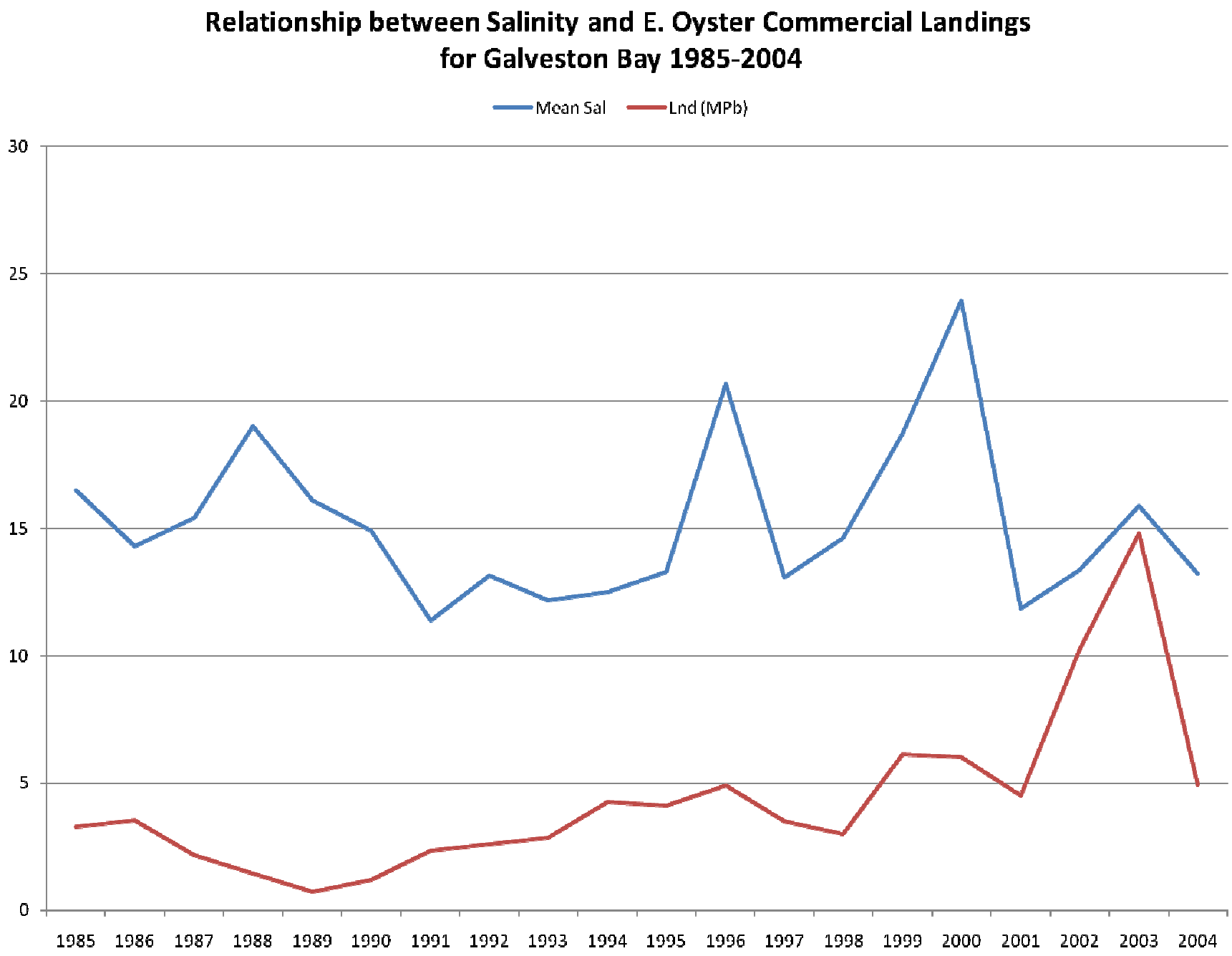
	Annual	Mean	Salinity			
	Minimum	Median	Maximum	Number	R-Square	Probability
Trinity	2.3	**5.9**	14.6	19	0.048	0.366
year+1				18	0.044	0.402
year+2				17	0.007	0.746
year+3				16	0.005	0.801
East Bay	7.0	**9.4**	20.7	19	0.004	0.499
year+1				19	0.003	0.821
year+2				19	0.001	0.877
year+3				18	0.005	0.771
Galveston	8.3	**12.2**	21.3	19	0.027	0.499
year+1				19	0.017	0.592
year+2				19	0.028	0.495
year+3				18	0.013	0.652
West Bay	15.1	**19.3**	29.5	19	0.004	0.789
year+1				19	0.000	0.938
year+2				19	0.000	0.993

Eastern Oyster CPUE in Galveston Bay



THE CONTRASTS

- Fishery-dependent commercial catch data vs. Fishery-Independent monitoring data
- Very Large vs Very Small sample size
- Non-random vs. random sampling
- ALL regulations are DESIGNED to reduce catch


Relationship between Salinity and E. Oyster Commercial Landings
for Galveston Bay 1985-2004
Mean Sal
Lnd (MPb)
30
25
20
15
10
5
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004

Correlations of Galveston Bay Oyster Size Classes

Spat=<26mm, Small=26-75mm, Market=>75mm

Size Class	Number	R-Square	Probability
SPAT vs SMALL			
Same year	20	0.015	0.604
Year + 1	19	0.0002	0.959
SPAT vs MARKET			
Year + 2	18	0.002	0.899
SMALL vs MARKET			
Same year	20	0.183	0.060
Year + 1	19	**0.510**	**0.0006**
Year + 2	18	**0.626**	**0.00009**
Year + 3	17	**0.451**	**0.003**

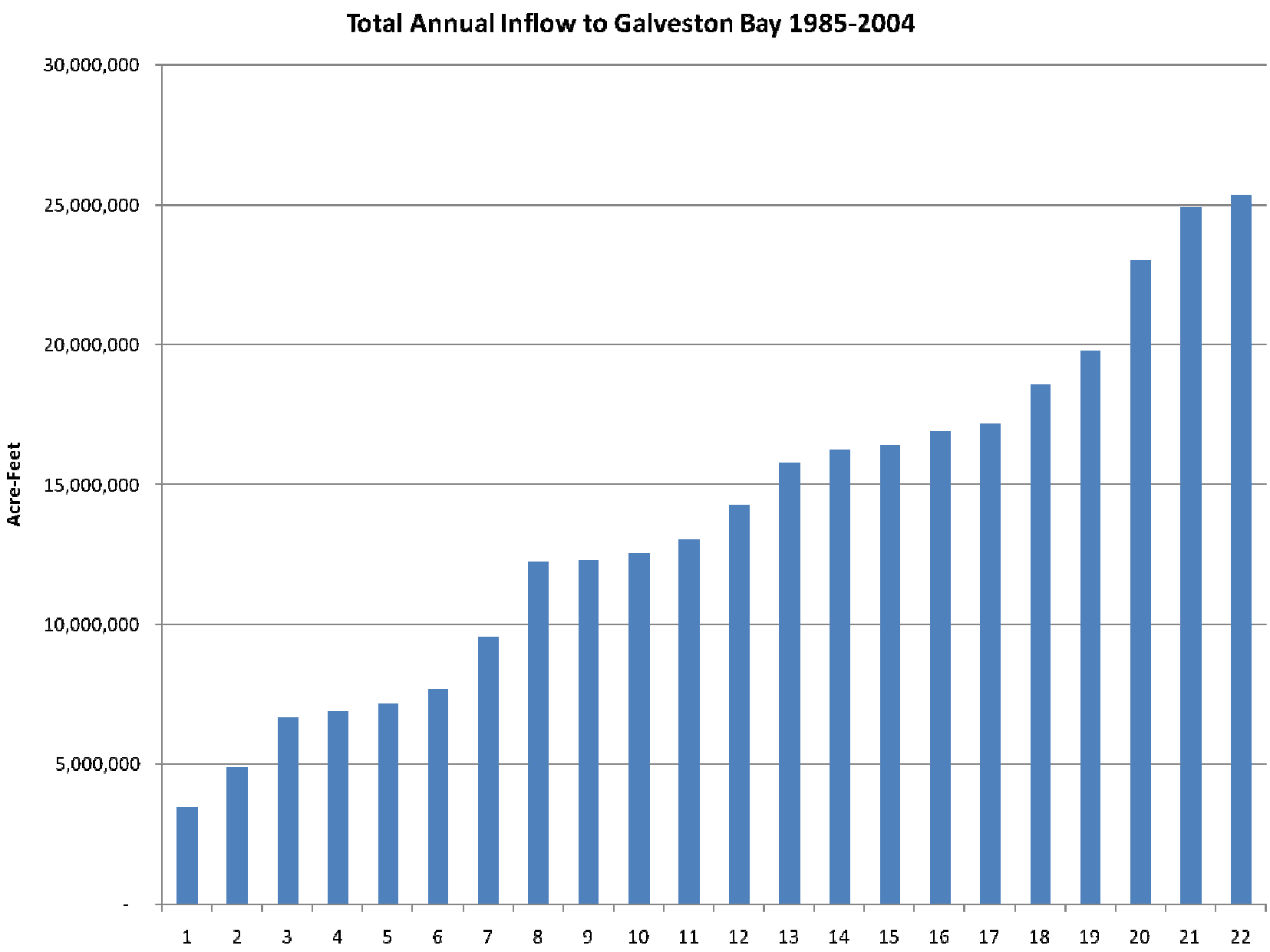
- Turner (2009) cites Hofstetter (1977) that spat set is greater in years of higher inflow, but spat survival is greater in years of lower inflow,
- And showed that CPUE demonstrates no relationship to harvest, thus cannot predict variations in harvest.

Inflow vs Spat and Small Oyster CPUE

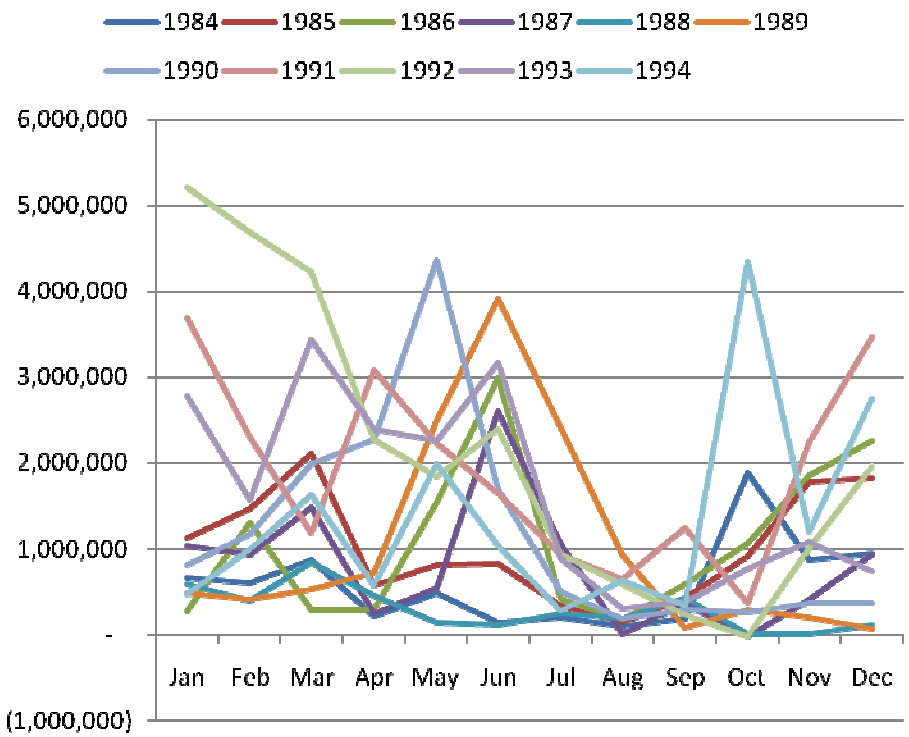
	R-Square	Probability
Inflow vs Spat Oysters		
Same Year	0.083	0.217
Year + 1	0.023	0.536
Inflow vs Small Oysters		
Same Year	0.174	0.067
Year + 1	0.060	0.313

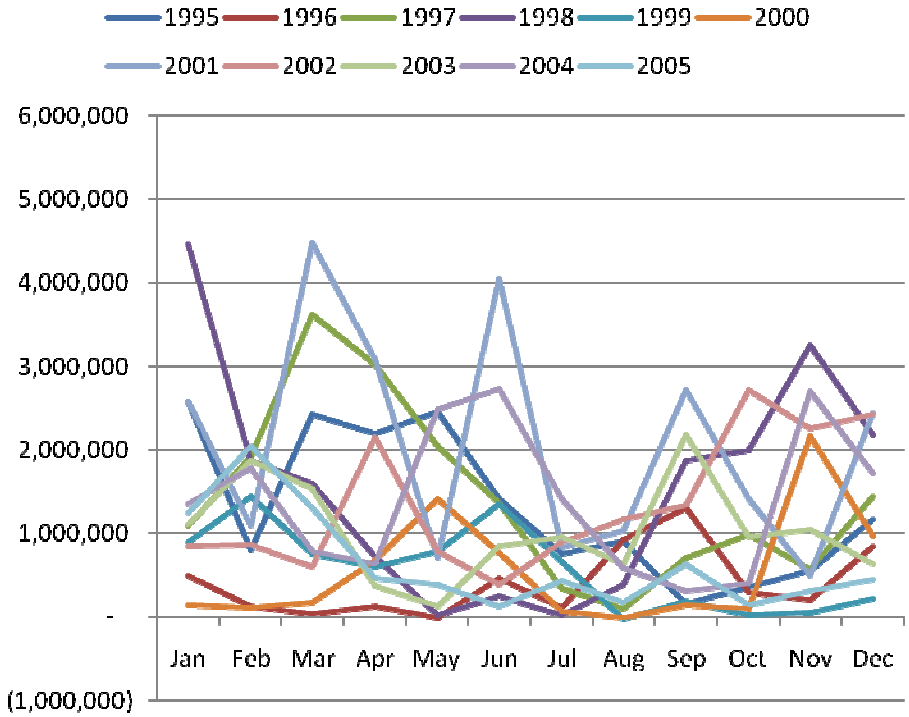
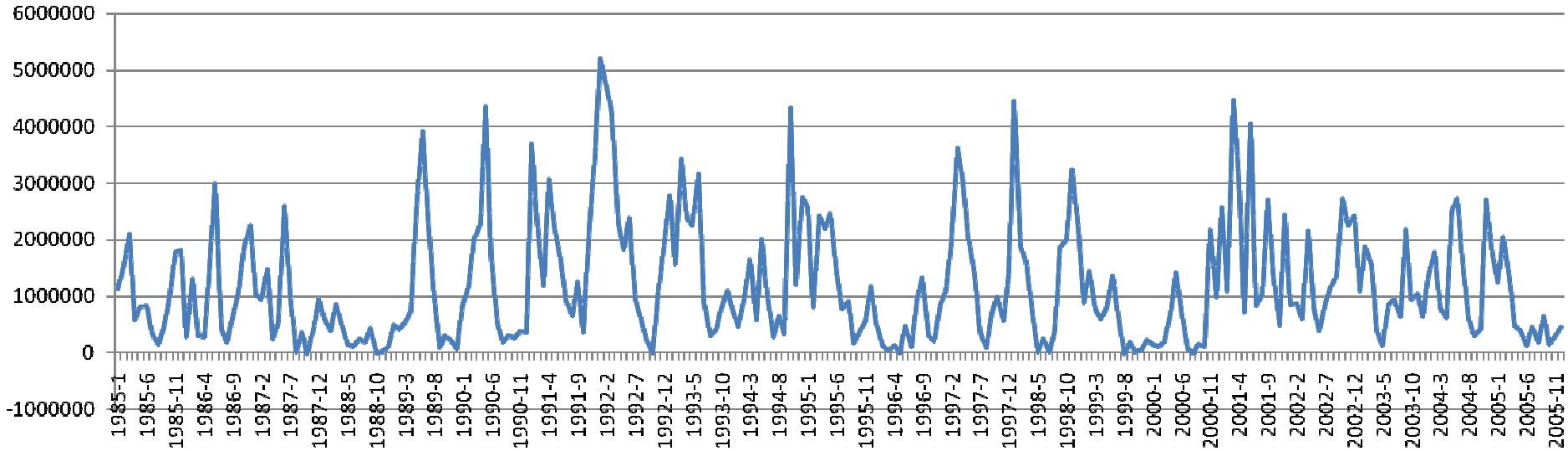
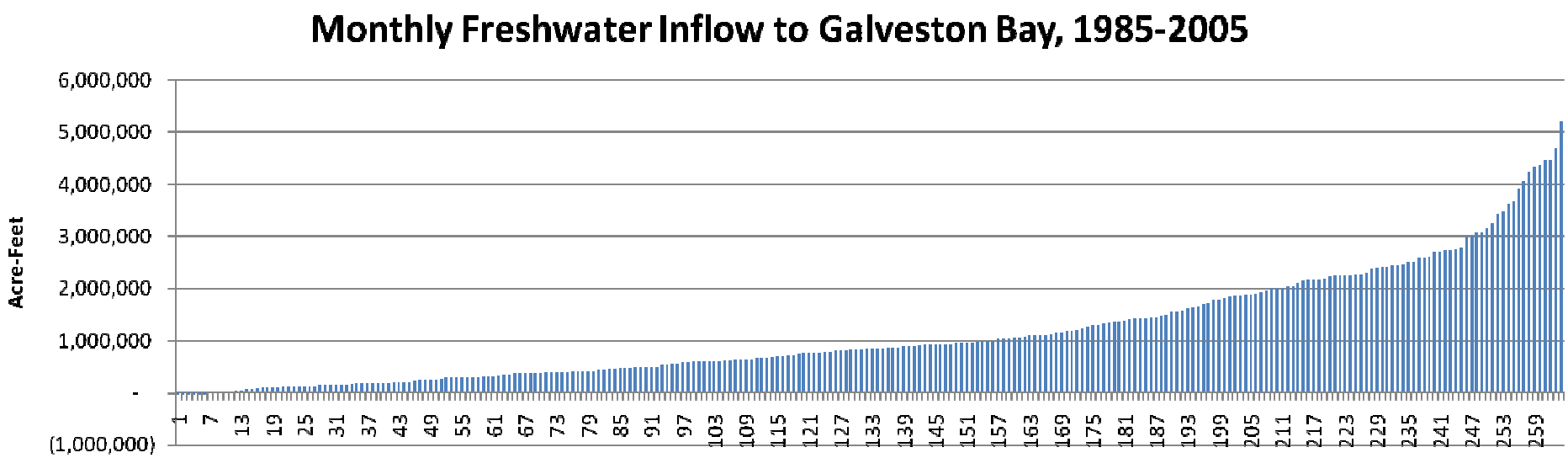
Conclusions

- 1. Theoretically, oyster abundance in Trinity Bay should increase with increasing salinity, while oyster abundance in West Bay should increase with decreasing salinity.
- 2. Oyster spat abundance does not predict small or market oyster abundance in subsequent years.
- 3. There is no relationship between salinity and total oyster abundance (all size classes).
- 4. Using oysters as an indicator of ecosystem health may be very tricky.


Total Annual Inflow to Galveston Bay 1985-2004
Acre-Feet
30,000,000
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
-
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

Monthly Inflows to Galveston Bay





Monthly Inflows to Galveston Bay 1985-2005